

REPORT OF INVESTIGATION
OF
WASTE WATER DISPOSAL OPERATIONS
EDISON AREA
KERN COUNTY, CALIFORNIA

PREPARED FOR
VALLEY WASTE DISPOSAL COMPANY

By

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May 1960

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Valley Waste Disposal Company
3624 Pierce Road
Bakersfield, California

Gentlemen:

There is submitted herewith my report on the investigation of the Race Track Hill oil field waste water disposal operations in the Edison Area, Kern County, California. The report includes a discussion of the geology and ground water hydrology, a geologic map and cross sections of the Edison Area, a summary of waste water disposal operations, and my conclusions regarding the possibility of pollution of the fresh ground waters by waste waters.

I wish to acknowledge the cooperation and assistance of employees and officials of the Valley Waste Disposal Company. I am particularly indebted to Mr. C. E. Burdick, General Manager, for his assistance in compiling and analyzing operational data on water disposal, and to Directors A. E. Woollen and C. W. Pierce for discussions and helpful suggestions during the course of the investigation. Finally, I should like to express appreciation to the operators who supplied much valuable geologic and other data used in the preparation of this report.

Respectfully submitted,

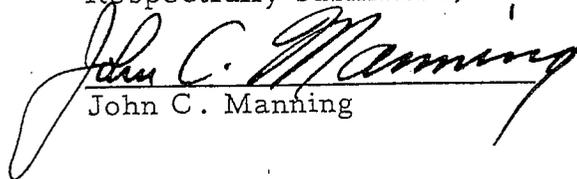

John C. Manning

TABLE OF CONTENTS

FOREWORD	i
SUMMARY AND CONCLUSIONS	i-iv

REPORT OF INVESTIGATION

LOCATION AND TOPOGRAPHY	1
PURPOSE AND SCOPE OF INVESTIGATION	1
GEOLOGY AND GROUND WATER HYDROLOGY	3
Introduction	3
Geology	3
Ground Water Hydrology	7
WASTE WATER DISPOSAL OPERATIONS	10
INFLUENCE OF WASTE WATERS ON FRESH WATER AQUIFERS	13

ILLUSTRATIONS

Plate I	Generalized Geologic Map of Edison Area	(in pocket)
Plate II	Generalized Cross Sections Through Edison Area	(in pocket)
Figure 1	Map Showing Generalized Ground Water Elevations in Southeast San Joaquin Valley, California	
Figure 2	Tabulation of Waste Water Disposal for the Period from January 1, 1960 to April 29, 1960	
Figure 3	Weekly Summary of Waste Water Disposal, January - April 1960	
Figure 4	Chemical Analysis of Influent Waste Water	

FOREWORD

This report presents the results of an investigation of the disposal of oil field waste waters northeast of Edison, California. It embraces a study of waste water disposal operations and their effect on the ground water hydrology of fresh-water aquifers in the Edison agricultural area.

To facilitate review of the more important results of the investigation the summary and conclusions are presented in this section followed by a complete report.

SUMMARY AND CONCLUSIONS

Valley Waste Disposal Company has constructed facilities for disposal of Race Track Hill oil field waste waters in Section 24, T. 29 S., R. 29 E., M.D.B.&M., near the west side of Cottonwood Creek canyon and several miles northeast of Edison, Kern County, California. The facility is built to handle 20,000 barrels of waste water per day, and the disposal sumps provide storage for more than one million barrels of water.

The disposal sumps are situated on both the Santa Margarita formation and on the thin edge of the Kern River-Chanac formation overlying the Santa Margarita. The original plan was to dispose of waste water by percolation from the sumps into the underlying Santa Margarita formation, but the impervious beds underlying the sumps have caused percolation rates to be much lower than expected. In order to get rid of the water and also to avoid the possibility of polluting the down-dip fresh water aquifers, the Company has installed irrigation sprinklers to provide for water disposal with a minimum of percolation.

About 30 acres of grass and other vegetation is currently being sprinkled, and the sprinkled plots will be enlarged as the need arises. For most of the year the waste water will be disposed of through the sprinklers by evapotranspiration into the atmosphere, and the sumps will be used mainly for storage during the two or three winter months each year.

There are two main ground water reservoirs under the Edison area; a deep confined reservoir in the Santa Margarita formation and a shallow unconfined ground water body in the Recent alluvium and Kern River-Chanac formation. The Santa Margarita reservoir receives little perennial recharge, and wells tapping this formation are, in effect, "mining" ground water from storage in the aquifer. The Recent alluvium and Kern River-Chanac beds receive recharge from the main Valley ground water reservoir to the west which is recharged annually by the Kern River. Most wells produce water of acceptable quality from both of the ground water reservoirs.

Subsurface barriers to water movement exist in the Edison area. A fault barrier makes a subsurface dam across the mouth of Caliente Creek, ponding ground water behind the fault and causing a difference in ground water levels of as much as 200 feet on the two sides of the barrier. A similar barrier also appears to affect ground water flow both southeast and northwest of Edison. (See map in Plate I.) The fault pattern northeast of Edison, with several active faults between Edison and the disposal site near Cottonwood Creek, suggests that there may be one or more barriers to the flow of ground water between the disposal site and the down-dip irrigation wells northeast of Edison.

Data from cores cut in the Santa Margarita formation from five wells northeast of Edison were analyzed to determine expected rates for ground water movement in the formation and to determine what sort of dilution factor might be expected for the waste water entering the ground water reservoir in the formation. For average values of permeability and porosity, under prevailing hydrologic conditions in the Santa Margarita formation, the average rate of ground water movement is about 15 to 20 feet per year down-dip from the disposal site. And, assuming all waste water is disposed of through percolation and all of it enters the Santa Margarita formation, the average annual dilution factor is about three-tenths of one percent for waste water relative to formation water. With sprinkling operations being carried on most of the year, the dilution factor will be less than one-tenth of one percent per year.

Based on the findings of this investigation, and considering the present and projected scope of water disposal operations, I conclude that there is no danger whatever of pollution in the aquifers of the Edison agricultural areas by oil field waste water disposed of at the site near Cottonwood Creek. [The slow rate of water movement in the formation, the strong possibility of subsurface fault barriers, and the dilution factor for a very small quantity of waste water in a very large volume of aquifer are factors that are reassuring when considered separately; but when all of these factors work against pollution, the evidence is conclusive. I do not believe that recognizable pollution would occur if the disposal sumps were used as planned,] but with disposal by evapo-transpiration through sprinklers during most of the year, pollution of ground water several thousand feet down-dip is practically impossible. With this latest plan

of operation for water disposal in effect, it will probably be a number of years before the small amount of percolation during the winter reaches the down-dip boundary of the Company's property.

LOCATION AND TOPOGRAPHY

The sumps for storage and disposal of waste water from the Race Track Hill oil field are located in Section 24, T. 29 S., R. 29 E., M.D.B.&M., Kern County, California. The sumps are constructed in rolling hills along the west side of Cottonwood Creek canyon at an average elevation of 1000 feet above sea level and about 300 to 400 feet higher than the irrigated lands northeast of Edison. Surface drainage for most of the area is to the northeast into Cottonwood Creek, and access to the area is along Breckenridge Road which winds down into Cottonwood canyon along the south and east sides of the disposal site.

PURPOSE AND SCOPE OF INVESTIGATION

The investigation of Race Track Hill oil field waste water disposal operations was begun in March 1960, and the purpose of the investigation was to determine:

1. The ground water hydrology in the vicinity of the disposal site near Cottonwood Creek and in the agricultural area northeast of Edison.
2. The effect of the waste water disposal on the fresh-water aquifers in the Edison area.

The scope of the investigation included:

1. Preparation of a generalized geologic map showing the water wells in the Edison area.
2. Preparation of two generalized geologic cross sections showing the fresh-water aquifers in the Edison area.
3. A brief analysis of the ground water hydrology in the Edison area.

4. A hydrologic analysis of waste water disposal operations at the Cottonwood Creek site.
5. Establishment of a U. S. Weather Bureau "Class A" type evaporation pan at the disposal site for measurement of evaporation opportunity in the site area.

GEOLOGY AND GROUND WATER HYDROLOGY

Introduction

Information on the geology and ground water hydrology of the Edison area was compiled from various sources. Much of the ground water data has been abstracted from published and unpublished reports of the Ground Water Branch of the U. S. Geological Survey. These reports were prepared by the Geological Survey in cooperation with the State of California, Department of Water Resources, and they are part of a continuing study of San Joaquin Valley ground water resources. The map in Figure 1 was copied from Plate 15 of U.S.G.S. Water Supply Paper 1469 entitled, "Ground Water Conditions and Storage Capacity in the San Joaquin Valley, California" (1959). The well data shown on Plate I of this report was taken from an unpublished U.S.G.S. report entitled, "Data for Wells, Springs, and Streams in the Edison-Maricopa Area, Kern County, California" (1959). Data on the quality of irrigation waters in the Edison area was obtained from a report prepared by the Department of Water Resources for the Central Valley Water Pollution Control Board entitled, "Effect of Oil Well Waste Discharge on Ground and Surface Waters, Edison Area, Kern County" (1953).

GEOLOGY

The Edison area is underlain by a thick sequence of marine and alluvial sediments that lie on a basement of old crystalline rocks. The sedimentary beds, ranging in age from Tertiary to Recent, trend generally northwest-southeast and dip southwesterly toward the center of the San Joaquin Valley. Both sediments and crystalline rocks are cut by a complex system of faults, some of which act

as barriers to ground water movement in the sediments.

The formations of interest in this investigation are the Santa Margarita formation of upper Miocene age, the Kern River-Chanac formation of Pliocene-Pleistocene age, and unconsolidated alluvium of Recent age. The outcrop pattern of the Santa Margarita formation is shown at its contact with the overlying Kern River-Chanac formation on the map of Plate I, and the general subsurface relationships of these formations are shown on the cross sections in Plate II.

The Santa Margarita formation, with a thickness of 1000 to 1400 feet in the Edison area, consists of a series of soft marine sandstones and conglomerates with interbeds of sandy siltstone and diatomaceous and pumiceous shale. The formation is a moderately good aquifer in some parts of the Edison area, and it usually produces water of fairly good quality. In general the Santa Margarita is an aquifer of moderate to low permeability, and it lies upon a series of impermeable beds known variously as "Round Mountain silt", "Edison shale", etc. The bottom of the Santa Margarita formation is the effective bottom of the ground water reservoir presently being drawn upon in the Edison area.

The Kern River-Chanac formation consists of alluvial clays, silts, sands, and conglomerates that range in thickness from a few feet at the disposal site near Cottonwood Creek to more than 2000 feet southwest of Edison. The beds are typical river-laid deposits and are discontinuous and lenticular in outline. Most of the conglomerates and sands contain some silt and clay, and they vary a good deal in their permeability to fresh water. Some beds exhibit high permeability and some exhibit low permeability, with the average for the formation being greater than that for the Santa Margarita formation. The Kern River-

Chanac formation and the overlying Recent alluvium supply most of the ground water pumped in the Edison area.

The Recent alluvium is composed of the same kind of river-laid beds as the Kern River-Chanac formation and can be distinguished at the surface only by its more unweathered, unconsolidated appearance. Recent alluvium is usually indistinguishable from Kern River-Chanac alluvium in the subsurface, and it is not differentiated on the map or cross sections accompanying this report.

Both the Santa Margarita and Kern River-Chanac formations are cut by numerous faults, some of which have been active in very recent times. There were many fractures in Recent alluvium at the ground surface in the Edison area after the Arvin-Tehachapi earthquake of July 1952, and records of aftershocks from this earthquake indicated several active faults in the region between Edison and the Cottonwood Creek waste water disposal site. The map in Plate I shows the approximate traces of a few of the more easily recognizable faults, and some of these are also shown on the cross sections in Plate II.

Faulting, even where the amount of displacement is small, often provides an effective barrier to the flow of ground water in otherwise permeable formations. The U. S. Geological Survey has mapped a typical fault barrier just southeast of Edison (Figure 1), and the present investigation has shown that this or a similar barrier apparently continues on to the northwest through the Edison area. Water levels on the two sides of the barrier show a difference in elevation of 150 to 200 feet, thus indicating the effectiveness of the barrier in inhibiting the flow of underground water.

Cross section A-B in Plate II shows several different levels for ground water in the Recent alluvium and Kern River-Chanac formations west of the Cottonwood Creek waste water disposal sites. These various water levels are probably due, at least in part, to subsurface damming behind faults.

GROUND WATER HYDROLOGY

The Kern River is the main source of recharge for ground water reservoirs in the southern San Joaquin Valley. Water from the river enters the alluvium and underlying sedimentary formations and percolates slowly down the water-level gradients toward regions of ground water discharge. Today most of the ground water discharge takes place through wells, and water levels are generally below the ground surface throughout the southern San Joaquin Valley.

The Kern River has cut down below the up-dip edges of the Santa Margarita formation northeast of Edison (see Plate I), and in this area the formation now receives very little natural recharge. Northeast of Edison the Santa Margarita formation is, in fact, a vast storage reservoir full of water but with a limited perennial supply. Most wells drawing on Santa Margarita sands in this area are "mining" water from storage in the aquifer. If pumping continues long enough, the supply of water in the formation will be gradually depleted. Depletion of an underground water reservoir of this type is analogous to depletion of an oil reservoir; prolonged pumping causes diminished pressure in the formation and continually decreasing yields from the well.

The Recent alluvium and Kern River-Chanac formations contain many pervious strata that are in hydraulic communication with the main Valley ground water body south and west of Bakersfield, and those beds provide both the reservoirs for storage and the conduits for perennial recharge for most of the ground water in the Edison area. Water-level contours on the map in Figure 1 indicate that most of the water recharging aquifers under the Edison area is moving in from the main Valley ground water body to the west. A minor amount of recharge

may come from flood waters in Caliente Creek, but most of the recharge from Caliente Creek is dammed behind the barrier southwest of the creek and is intercepted by wells near the mouth of the creek.

The map in Plate I shows the locations of most of the water wells in the Edison area, and a study of water levels from these wells reveals two distinct ground water provinces within the Recent alluvium and Kern River-Chanac formations. The different provinces are probably formed by the ground water barrier shown on the map. Southwest of the barrier water level elevations are about 200 to 250 feet above sea level, as contrasted with levels of 350 to 500 feet northeast of the barrier; and the wells southeast of the barrier draw upon alluvial beds that are recharged from the main Valley ground water body to the west. Northeast of Edison and west of Caliente Creek the small number of wells and scattered locations indicate the paucity of useable ground water in the alluvial beds northeast of the barrier. A few wells northeast of Edison are "mining" water from the Santa Margarita formation, but most wells completed in the Kern River-Chanac formation have small yields and produce water of poor quality, often with traces of oil in the water. This is not surprising if one remembers that most formations receive their recharge from the Kern River, and northeast of Edison the alluvial beds are far above river level and are cut off from the main Valley ground water body by the barrier.

Due east of Edison and north of Highway 466, beginning in about Sections 6 and 7 of T. 30 S., R. 30 E., M.D.B.&M., there is a group of wells that produce from alluvial beds and from the Santa Margarita formation.

These wells receive recharge from Caliente Creek, and their water levels indicate that they are outside of the area where they could possibly be influenced by the waste water disposal operations near Cottonwood Creek.

Most of the aquifers under the Edison area produce water of acceptable quality for domestic use and for irrigation of the crops being grown in the district. Water from the Santa Margarita formation seems to be of moderately good quality throughout the area; and where the alluvial beds produce poor water, as in the region northeast of Edison, wells are generally drilled on down until they tap Santa Margarita water. Consequently, it is important to maintain acceptable quality in water of the Santa Margarita formation.

WASTE WATER DISPOSAL OPERATIONS

The Valley Waste Disposal Company has constructed 17 disposal sumps at its site near Cottonwood Creek in Section 24, T. 29 S., R. 29 E., M.D.B. & M., Kern County, California. The sumps have a total storage of 1,101,000 barrels (141.92 acre-feet) and an area of 14.79 acres of open water surface when full. Oil field waste water is delivered by pipe line into 3 high-level ponds for final cleaning before being distributed by gravity flow to 17 sumps for storage and disposal. The disposal sumps are located along natural drainage courses and were constructed by scooping out basins and building small earth dams across the drainage courses below the basins. Several sumps are bottomed in the Santa Margarita formation, but most are on the thin edge of Kern River-Chanac beds overlying the Santa Margarita. Disposition of waste water for the first four months of 1960 is summarized in the table of Figure 2, and is shown graphically in Figure 3. A complete chemical analysis of typical waste water entering the disposal site is given in Figure 4.

The formations underlying the sumps are relatively impermeable and only a part of the total water input could ever be disposed of through percolation in the disposal sumps. Percolation rates from the sumps will gradually decline with use, and most of the waste water will eventually have to be disposed of through sprinklers, and hence through evaporation and transpiration into the atmosphere. Evaporation from open water surfaces in the sumps will account for a considerable volume of water during the time that water is stored in the sumps, and evaporation from the soil in the sprinkled areas will

also use up a sizeable quantity of water. Transpiration from growing vegetation in the sprinkled areas and around the sumps will account for much of the water during the growing season when sprinkling operations are used for water disposal. Phreatophytes, or "well plants", have been planted near the sumps and will also transpire water into the atmosphere during the year.

Several hundred cuttings of Tamarix, a boron-tolerant phreatophyte, have been planted around the sumps. These plants, commonly called Salt Cedar, send roots down to the water table and withdraw water directly from the ground water reservoir. Tamarix is the heaviest known user of ground water, and at many places throughout the Southwest programs are now under way to eradicate these plants because of the large quantities of ground water they waste into the atmosphere each year. If the experimental plantings thrive, more Tamarix will be planted to help further the disposition of waste water into the atmosphere. Since they transpire water night and day throughout most of the year, a large grove of Tamarix trees can put a considerable volume of water into the atmosphere each year.

A United States Weather Bureau "Class A" type evaporation pan has been installed at the site and is being measured to determine the evaporation opportunity in the site area throughout the year. Records from the evaporation pan will be useful in estimating total evaporation from open water surfaces in the sumps and from moist soil in the sprinkled areas.

Valley Waste Disposal Company began draining the sumps in April, and the water coming in now is being applied to about 30 acres of grassland by

irrigation sprinklers. This acreage will be expanded as needed and water will be disposed of through evapo-transpiration in the sprinkled areas during spring, summer and autumn months when evaporation opportunity is high. None of this water is expected to seep into the ground below the soil zone, and there should be practically no addition to ground water in the disposal area during the period of sprinkling. In the long run, the sumps will probably be used for winter storage of water during the time when evaporation is at a minimum, but during the remaining 9 or 10 months of the year the sumps will be mostly dry and water will be disposed of through the sprinklers. Operations according to this plan will result in an almost negligible addition to ground water under the disposal area each year.

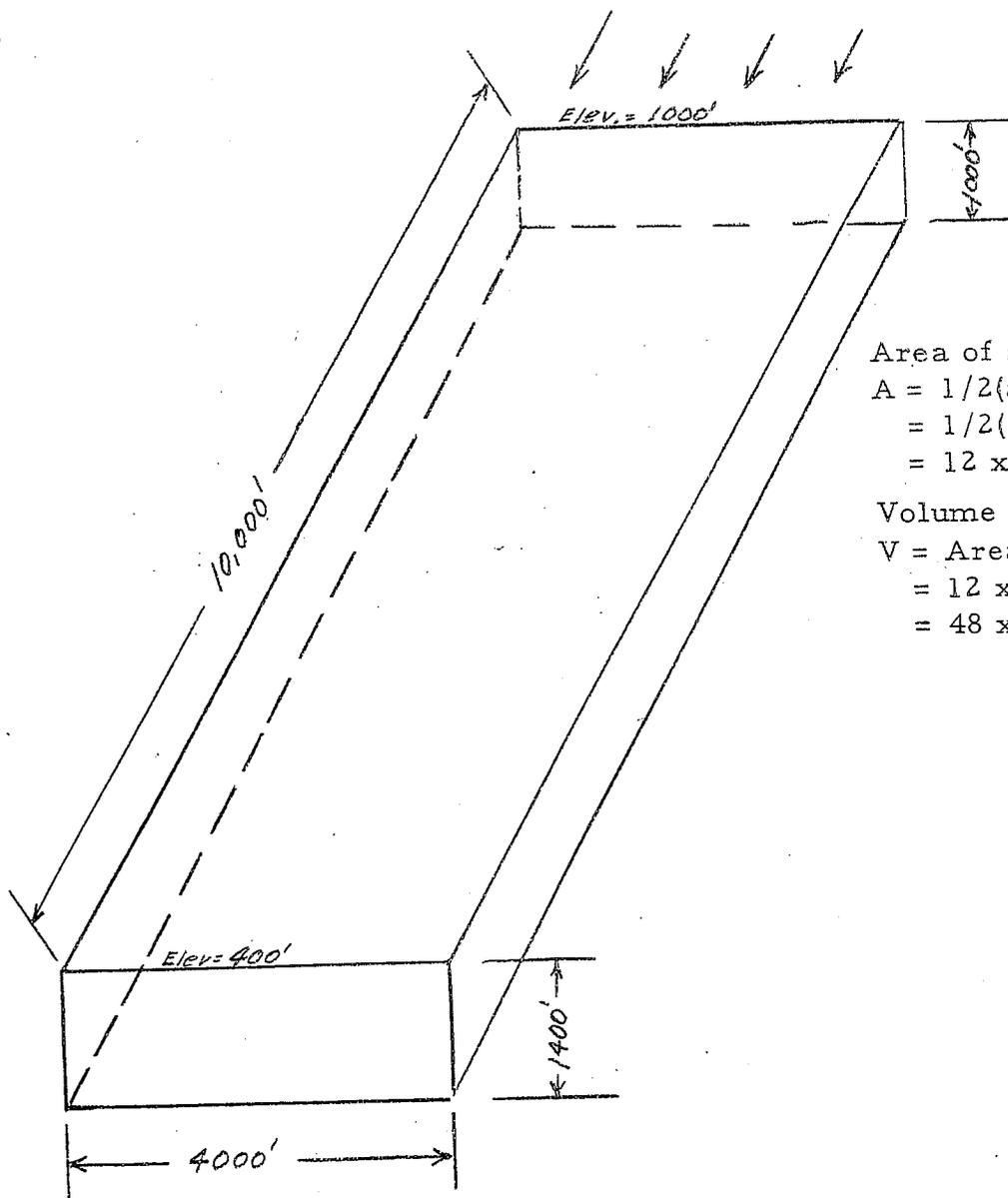
INFLUENCE OF WASTE WATERS ON FRESH WATER AQUIFERS

From a consideration of the water disposal operations outlined above and from a study of the geology and ground water hydrology of the area between Edison and the disposal site near Cottonwood Creek, it seems virtually certain that no waste water will ever reach the nearest down-dip irrigation wells. In the event that some of the water did eventually travel down the gently-dipping beds and reach the wells, the enormous volume of the aquifers, in contrast to the small quantities of waste water, would insure so much dilution of the waste water that it probably could never be identified in the down-dip wells. Operations at the disposal site indicate that only a small part of the total annual inflow of Race Track Hill waste water will ever percolate to the underlying ground water body, and the fault pattern in the area suggests that this water probably would be prevented from traveling down the dip of the formations by fault barriers.

Assuming, however, that some of the water did find its way into the down-dip aquifers, we can show by sample computations what the order of magnitude of the aquifer pollution due to waste water might be. We can also investigate the kind of flow rates we might expect for the waste water traveling down the ground water gradient in the formations under the prevailing conditions. Analyses of cores from 5 wells in the down-dip irrigated area give an average permeability of 300 millidarcys and an average porosity of 25 percent for the Santa Margarita formation. To be conservative let us assume that all of the waste water inflow goes into the ground and that all of it enters the Santa

Margarita formation and percolates down-dip without hindrance of fault barriers. To simplify the computations, a restricted volume of Santa Margarita formation was selected directly down-dip from the disposal site, although if the water were free to travel in the formation it most certainly would diffuse into a much larger volume than that shown in the sketch. The sketch and sample computations are shown on the following pages.

Total Input = 20,000 bbls./day = 941 ac.-ft./yr.



Area of side:
 $A = 1/2(a+b)h$
 $= 1/2(1400+4000)10,000$
 $= 12 \times 10^6 \text{ ft.}^2$

Volume of prism:
 $V = \text{Area} \times \text{width}$
 $= 12 \times 10^6 \times 4 \times 10^3$
 $= 48 \times 10^9 \text{ ft.}^3$

Prism of Santa Margarita formation making up hypothetical disposal reservoir for Race Track Hill Oil Field waste waters, directly down-dip from disposal sumps.

Assume:

1. 100% saturation
2. No fault barriers to subsurface percolation
3. All waste water enters and percolates in Santa Margarita formation
4. Average porosity of 25 percent (0.25)
5. Average permeability of 300 millidarcys
6. Hydraulic gradient of $0.06 \left(\frac{1000' - 400'}{10,000'} \right)$

To compute the dilution factor for the prism of Santa Margarita formation under consideration we can divide the annual increment of waste water by the effective volume of percolating water in the formation.

Total volume is $48 \times 10^9 \text{ ft.}^3$, and multiplying this by the average porosity of 0.25 gives an effective volume of $12 \times 10^9 \text{ ft.}^3$ for the storage and transmission of water. This can be expressed in acre-feet by dividing by 43,560;

$$V \text{ effective} = \frac{12 \times 10^9 \text{ ft.}^3}{43,560 \text{ ft.}^3} = 275,482 \text{ ac.-ft.}$$

Now divide the annual inflow of waste water, 941 ac.-ft., by the effective volume to obtain the dilution factor.

$$\text{Dilution factor} = \frac{941}{275,482} \times 100 = \underline{0.34\%}$$

Water moves through the Santa Margarita formation in accordance with

Darcy's Law:

$$Q = P I A$$

Where: Q = flow rate in gallons per day

P = formation permeability in gallons per day per square foot at a water temperature of 60° F. and unit hydraulic gradient.

I = hydraulic gradient causing water to flow in formation

$$\left(\frac{h_1 - h_2}{L} \right)$$

A = area in square feet, through which flow takes place.

and since

$$\frac{Q}{A} = V$$

Where: V = Velocity of flow in feet per day

Darcy's Law can be written: $V = P I$ Where P is now expressed in cubic feet per day rather than in gallons per day.

Now, using the data given above for the Santa Margarita formation, we can apply Darcy's Law and determine the average rate of water movement from the disposal sumps toward the down-dip wells. Converting the value of P from millidarcys to Meinzers (ground-water permeability units), and expressing the gallons per day in P as cubic feet per day, we get

$$\begin{aligned} V &= P I \\ &= 0.74 \frac{\text{ft.}^3}{\text{ft.}^2} \text{ day} \times 0.06 \\ &= 0.0444 \text{ ft./day} \\ &= \underline{16' / \text{year}} \end{aligned}$$

On the average then, we can say that under existing conditions of flow in the formation we would expect the waste water to advance down-dip (along the hydraulic gradient) at a rate of about 15 to 20 feet per year.

The sample computations on the previous pages put the problem of pollution of fresh-water aquifers by Race Track Hill waste water into its proper perspective. The Valley Waste Disposal Company is altering its operations to take full advantage of the naturally high evaporation opportunity in the southern San Joaquin Valley, and the Company plans to use the disposal sumps for storage during the winter months; during the remainder of the year the sumps will be dry. At least two-thirds of the total inflow to the disposal area will eventually be disposed of by evapo-transpiration, and the total waste water available for percolation in the sumps probably will not exceed 300 acre-feet per year. Even this amount will be further diminished by evaporation from open water surfaces and transpiration through phreatophytes around the sumps. Using a figure of 300 acre-feet per year percolated, the dilution factor for the hypothetical aquifer volume used above becomes 0.11 percent.

From the above it may be concluded that, even though the waste water may contain excessive amounts of boron or other constituents, with a dilution factor of about one-tenth of one percent the chances are extremely small that we could ever detect the waste water if it did get as far as the down-dip irrigation wells. An earlier report on oil field waste waters in the Edison area, prepared by the Department of Water Resources, showed both positive and negative variations of as much as 0.31 to 0.47 parts per million of boron. The investigators attributed these changes in reported boron concentrations to variations in sampling procedure and analysis, dilution of recharge water, and changes induced by the pumping of wells.

Any changes likely to occur in the boron content of Santa Margarita formation water northeast of Edison as a result of waste water disposal in Section 24 would, according to the dilution factors computed above, fall within a range of variation to be expected from sampling errors, etc. as found in the earlier investigation. In other words, even if water were to percolate from the sumps without hindrance of faults, etc., the small quantities percolated per year and the large volume of aquifer for dilution of waste water makes it very unlikely that the waste water could be identified as such a few thousand feet down-dip from the sumps.

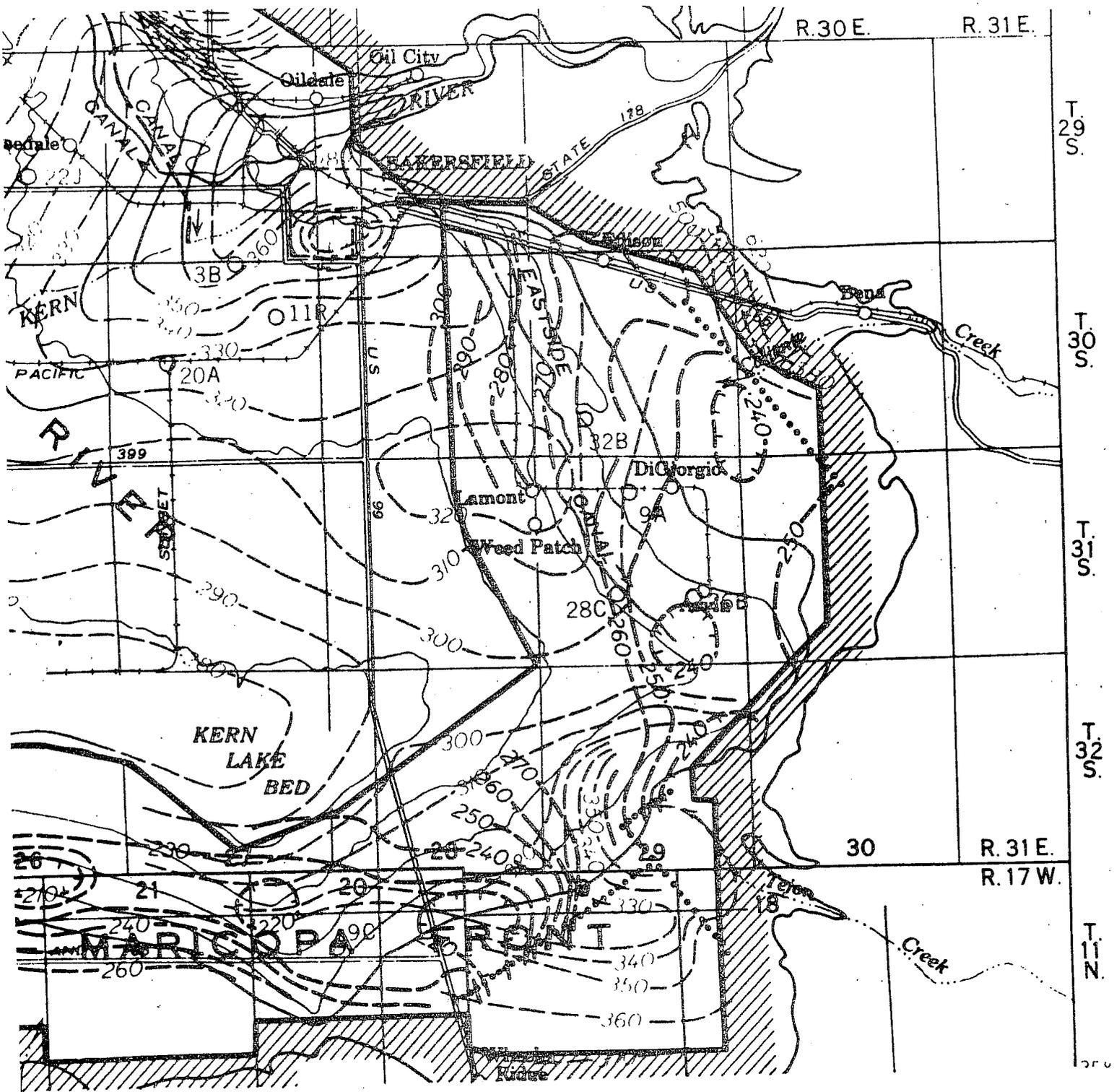


FIGURE 1

Map Showing Generalized Ground Water Elevations in the Southeast San Joaquin Valley, California. *

* Copied from Plate 15 of U. S. Geological Survey Water Supply Paper 1469 (1959).

DISPOSITION OF WASTE WATER
 AT
 DISPOSAL SITE NEAR COTTONWOOD CREEK
 FOR
 THE PERIOD JANUARY 1, 1960 to APRIL 29, 1960

<u>Week Ending</u>	<u>Water put into system at upper cleaning sumps in acre-feet</u>	<u>Water disposed of in disposal sumps through evaporation & percolation in acre-feet</u>
1-8-60	16.52	No Record
1-15-60	17.27	No Record
1-22-60	7.98	No Record
1-29-60	6.51	5.87
2-5-60	6.91	5.58
2-12-60	7.19	5.28
2-19-60	9.66	5.01
2-26-60	11.60	5.97
3-4-60	12.31	7.54
3-11-60	12.33	8.31
3-18-60	12.97	8.66
3-25-60	12.80	9.54
4-1-60	12.33	9.01
4-8-60	12.24	9.42
4-15-60	15.21	10.05
4-22-60	16.00	9.96
4-29-60	<u>15.94</u>	<u>9.36</u>
Totals	205.77	109.56

Note: Total capacity of sumps being used is 940,900 barrels or 121.28 acre-feet.
 Total capacity of sumps constructed is 1,101,000 barrels, or 141.92 acre-feet.

FIGURE 2

WEEKLY SUMMARY OF WASTE WATER
DISPOSAL, January - April 1960

(Data taken from Table in Figure 2)

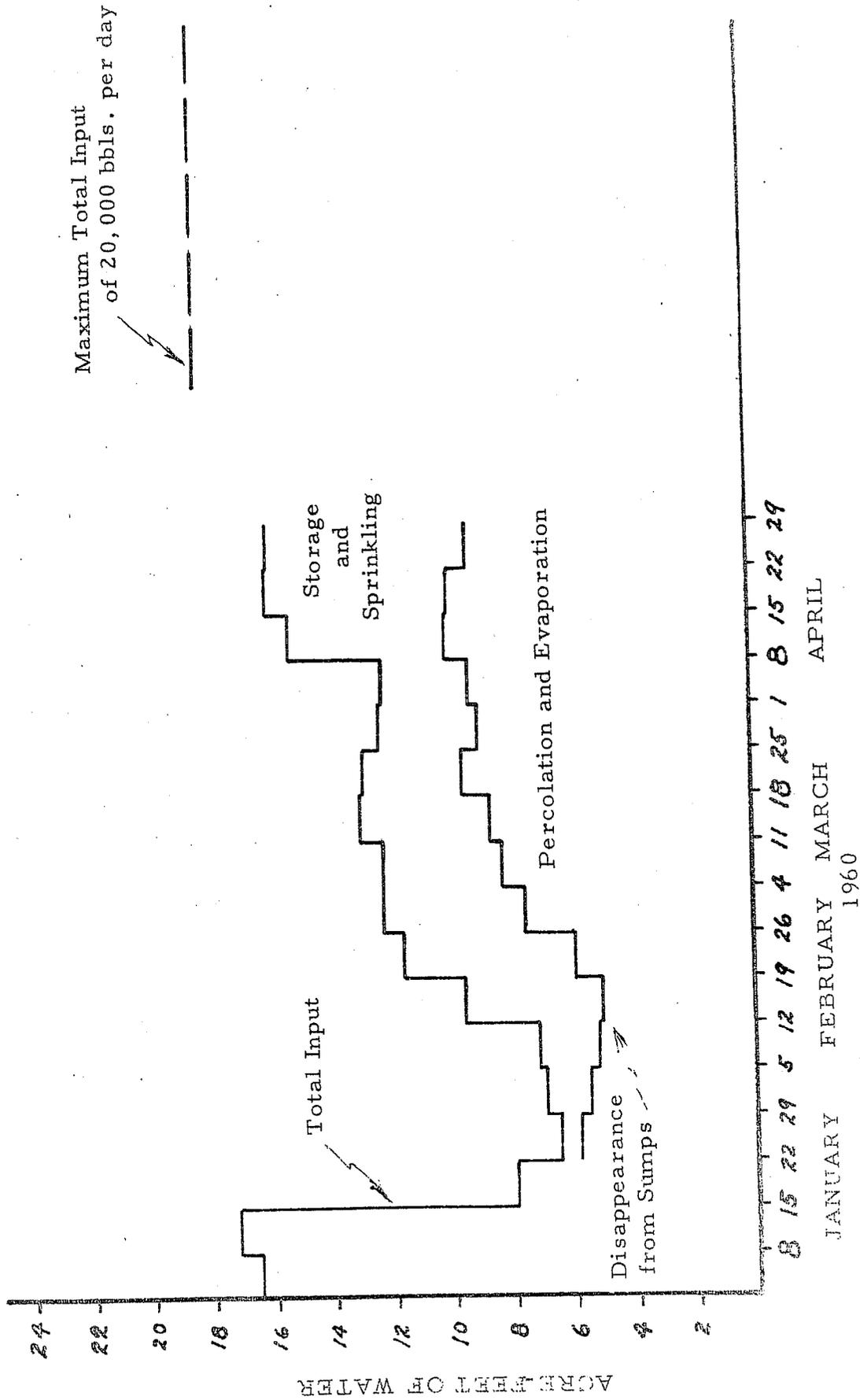


FIGURE 3

HORNKOHL LABORATORIES, INC.
 CHEMICAL AND TESTING ENGINEERS
 714 TRUXTON AVENUE
 BAKERSFIELD, CALIFORNIA

April 7, 1960

Laboratory No. 117,384

Marked Race Track Water to Top Side

Sample Water

Received April 1, 1960

Submitted by Valley Waste Disposal Co.
 3624 Pierce Road
 Bakersfield, California *****

SPECIAL STATE WATER ANALYSIS

<u>Constituents</u>	<u>Parts Per Million</u>	<u>Grains Per Gallon</u>
Carbonates	0.0	0.00
Bicarbonates	172.0	10.10
Chlorides	2609.9	152.63
Sulfates	15.4	0.90
Sulfides	0.0	0.00
Calcium	123.2	7.20
Magnesium	5.4	0.32
Sodium	1657.2	96.91
Potassium	46.9	2.47
Boron	17.0	0.99
Fluorides	11.2	0.65
pH	7.3	
Conductivity $\text{Mhos/cm}^3 \times 10^6 @ 25^\circ\text{C.}$	5661.5	
Total Solids @ 105°C.	4572.2	267.38

Respectfully submitted,

HORNKOHL LABORATORIES, INC.

Frederick Fischer
 Frederick Fischer, Chief Chemist

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FIGURE 4